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भाग 3 अंकीय समाकलित परिपथ-मापन पद्धतियां

अनुभाग 2 स्थिर गुणधर्म

Indian Standard

SEMICONDUCTOR DEVICES — INTEGRATED CIRCUITS

PART 3 DIGITAL INTEGRATED CIRCUITS — MEASURING METHODS

Section 2 Static Characteristics

UDC 621·3·049·77·037·37 : 621·317·3

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NEW DELHI 110002

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FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Semiconductor Devices and Integrated Circuits Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

This standard is one of a series of standards on integrated circuits, measuring methods of digital integrated circuits covering static characteristics. Other sections of this part are:

Section 1 General

Section 3 Dynamic Measurements

This standard is based on IEC Pub 748-2 'Semiconductor devices, integrated circuits: Part 2 Digital integrated circuits', issued by the International Electrotechnical Commission (IEC).

In reporting the results of test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

SEMICONDUCTOR DEVICES — INTEGRATED CIRCUITS

PART 3 DIGITAL INTEGRATED CIRCUITS — MEASURING METHODS

Section 2 Static Characteristics

1 SCOPE

This standard (Part 3/Sec 2) covers the measuring methods for static characteristics of digital integrated circuits.

2 REFERENCES

The following Indian Standards listed below are necessary adjuncts to this standard:

IS No.	*Title*
1885 (Part 7/Sec 5) : 1971	Electrotechnical vocabulary: Part 7 Semiconductor devices, Section 5 Integrated circuits and microelectronics
3715 (Part 1) : 1971	Letter symbols for semiconductor devices: Part 1 General aspects (*first revision*)
12970 (Part 1) : 1990	Semiconductor devices—integrated circuits: Part 1 General

3 TERMINOLOGY

For the purpose of this standard (Part 3/Sec 2), the terms and definitions given in IS 1885 (Part 7/Sec 5) : 1971, and provisions of 3 of IS 12970 (Part 1) shall be applicable.

4 LETTER SYMBOLS

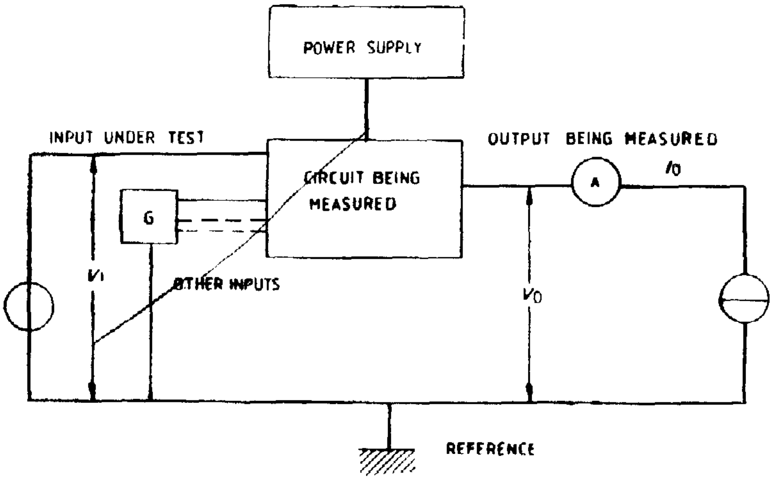
For the purpose of this standard, the letter symbols given in IS 3715 (Part 1) : 1971 shall be applicable.

5 HIGH-LEVEL AND LOW-LEVEL OUTPUT VOLTAGES (V_{OH} AND V_{OL})

a) *Purpose* — To measure the high-level and low-level output voltages under specified conditions.

b) *Circuit diagram* (*see* Fig. 1)

c) *Circuit description and requirements* — The measurement equipment should provide, where required, the specified output conditions. Where appropriate, the pulse generator should provide a sufficient number of independent pulse sequences to enable the output condition of the circuit being measured to be set up according to the function table. The current generator should be capable of acting as either a source or sink of current.



G = Voltage source and pulse generator.

FIG. 1 CIRCUIT FOR MEASUREMENT OF HIGH-LEVEL AND LOW-LEVEL OUTPUT VOLTAGES

d) *Measurement procedure* — The integrated circuit is connected as specified to the measurement circuit of Fig. 1, the supply and input voltages are set to their specified values and the appropriate conditions are applied to the output terminals. The temperature is set to the specified value and checked immediately before and after the measurement. The input conditions and, where appropriate, the input pulse sequences necessary to set up the specified static output level are applied. The output voltage V_0 is measured.

NOTE — Provided that the worst-case combinations of input voltages are used, this measurement can simultaneously verify that the circuit under test meets both the specified input and the associated output voltage limits.

For example:

Function	*Applied Conditions*		*Measurement Limit*
	Input Under Test	Other Input(s)	(Output Being Measured)
NAND	V_{ILA}	V_{IHB}	V_{OHB}
	V_{IHB}	V_{IHB}	V_{OLA}
AND	V_{IHB}	V_{IHB}	V_{OHB}
	V_{ILA}	V_{IHA}	V_{OLA}

e) *Specified conditions*

1. Ambient or reference-point temperature,
2. Setting-up procedure (where appropriate) and sequence of measurement,
3. Value(s) of the supply voltage(s),
4. Input voltage(s)
5. Output current(s), and
6. Direction(s) of current(s).

6 HIGH-LEVEL AND LOW-LEVEL INPUT CURRENT (I_{IH} AND I_{IL})

a) *Purpose* — To measure the high-level and low-level input currents under specified conditions.

b) *Circuit Diagram* (*see* Fig. 2)

c) *Circuit Description and Requirements* — Where appropriate, the pulse generator *G* should provide a sufficient number or independent pulse sequences to enable the specified internal logic state to be set up. The measurement equipment should provide, where required, the specified output conditions.

d) *Measurement Procedure* — The integrated circuit is connected as specified to the measurement circuit (*see* Fig. 2), the supply and input voltages are set to their specified values and the appropriate conditions are applied to the output terminals. The temperature is set to the specified value and checked immediately before and after the measurement. Where appropriate, the input pulses necessary to set up the specified logic state are applied. The resulting current I_I is measured :

NOTE — Usually, each input is measured separately.

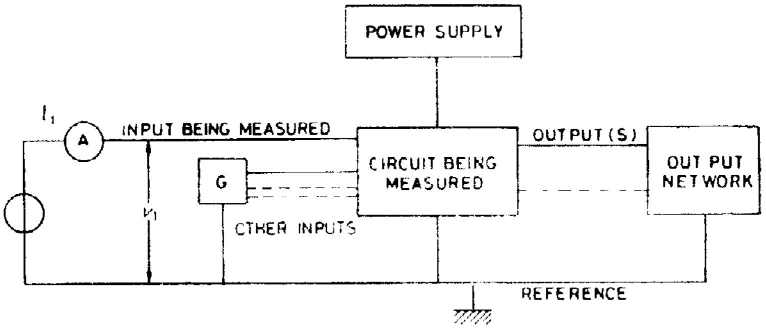
e) *Specified Conditions*

1. Ambient or reference-point temperature,
2. Setting-up procedure (where appropriate) and the sequence of measurements,
3. Value(s) of the supply voltage(s),
4. Input voltage(s), and
5. Output conditions, where appropriate.

7 SHORT CIRCUIT OUTPUT CURRENT (I_{OS})

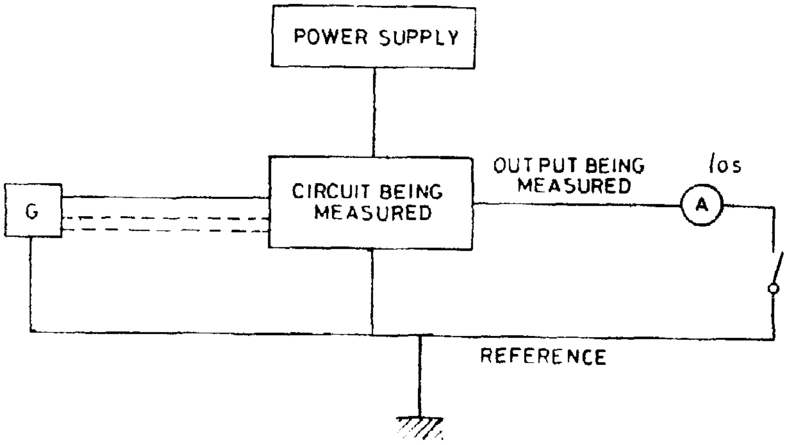
a) *Purpose* — To measure the short-circuit output current under specified conditions.

b) *Circuit Diagram* (*see* Fig. 3)



G — Voltage source and pulse generator.

FIG. 2 CIRCUIT FOR MEASUREMENT OF HIGH-LEVEL AND LOW-LEVEL INPUT CURRENTS



G = Voltage source and pulse generator.

FIG. 3 CIRCUIT FOR MEASUREMENT OF SHORT-CIRCUIT OUTPUT CURRENT

c) *Circuit Description and Requirements* — Where appropriate, the pulse generator should provide a sufficient number of independent pulse sequences to enable the output condition of the circuit under test to be set up according to the function table. The measurement equipment should be capable of implementing a short-circuit between the output terminal and a specified reference point (for a specified duration, if appropriate) and of measuring the short-circuit current without influencing significantly the short-circuit itself.

d) ***Precautions to be Observed*** — The maximum rated power dissipation should not be exceeded.

e) *Measurement Procedure* — The integrated circuit is connected as specified to the measurement circuit (*see* Fig. 3). The supply and input voltages are set to their specified values. The temperature is set to the specified value and checked immediately before and after the mesurement. Where appropriate, the input pulse sequences necessary to set up the specified static output level are applied.

The output terminal under test is connected to the specified reference point and the short-circuit the current I_{OS} is measured. Before application of the short-circuit, the output voltage is forced (for example, by means of the relevant input level combination) to a level as far as possible from the reference level.

f) *Specified Conditions*

1. Ambient or reference-point temperature,
2. Setting-up procedure (where appropriate),
3. Value(s) of the supply voltage(s),
4. Input voltage(s),
5. Short-circuit duration, if appropriate,
6. Conditions at other terminals, and
7. Reference point (for the short-circuit).

8 POWER SUPPLY CURRENT UNDER STATIC CONDITIONS

a) *Purpose* — To measure the power supply current under specified static conditions.

b) *Circuit Diagram* (*see* Fig. 4)

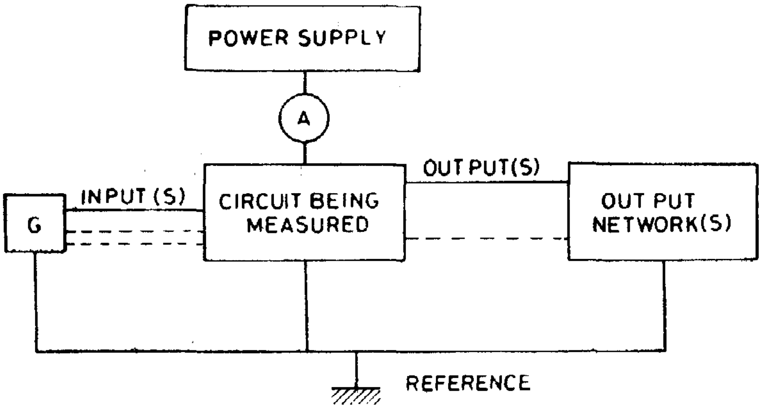
c) *Circuit Description and Requirements* — Where appropriate, the pulse generator should provide a sufficient number of independent pulse sequences to enable the output condition(s) of the circuit under test to be set up according to the function table.

d) *Measurement Procedure* — The integrated circuit is connected as specified to the measurement circuit (*see* Fig. 4), the supply and input voltage are set to their specified values. The temperature is set to the specified value and checked immediately before and after the measurement. Where appropriate, the input pulse sequences necessary to set up the required static output level are applied.

The relevant power supply current is measured.

e) *Specified Conditions*

1. Ambient or reference-point temperature,
2. Setting-up procedure (where appropriate) and sequence of measurement,
3. Value(s) of the supply voltage(s),
4. Inputs voltage(s), and
5. Output network(s).



G = Voltage source and pulse generator.

FIG. 4 CIRCUIT FOR MEASUREMENT OF POWER SUPPLY CURRENT UNDER STATIC CONDITIONS

9 (INPUT) THRESHOLD VOLTAGES AND HYSTERESIS VOLTAGE

a) *Purpose* — To measure the (input) threshold voltages and to determine the hysteresis voltage of a combinatorial logic circuit by a measuring method such that the result is independent of the dynamic characteristics of the circuit being measured.

b) *Circuit Description and Requirements* — The measuring circuit is shown in Fig. 5.

The equipment shall be capable of measuring the output voltage V_0 as a function of the input voltage V_I. The measuring equipment should provide a triangular input signal whose waveform is either a ramp or a series of steps; the equipment should also provide the input and output networks and the supply voltage(s); it shall keep the circuit being measured at the specified temperature (T_{amb} or T_{case}).

c) *Measurement Procedure* — The circuit being measured is set to the specified temperature (T_{amb} or T_{case}). The input and output terminals are connected as specified and the supply voltage(s) is (are) applied. The signal generator is adjusted and connected. The output signal V_0 of the circuit being measured is applied to the measurement equipment, for instance to the Y-input of an oscilloscope. The triangular input signal V_I of the circuit being measured is applied to the measurement equipment, in the above case to the X-input of the oscilloscope. The input voltage is measured or read as $V_{IT}+$ (or V_{ITP}) when the output voltage V_0 just switches to the opposite level or as V_{IT-} (or V_{ITN}) when the output voltage V_0 switches to the original level; these two values are the (input) threshold voltages.

The result is the transition characteristics shown in Fig. 6. The hysteresis voltage V_{hys} results from:

$$V_{hys} = V_{IT+} - V_{IT-} \text{ or : } V_{ITP} - V_{ITN}$$

NOTE — Fig. 7 and Fig. 8 represent the transition characteristics for two different input waveforms, either of which may used for this method.

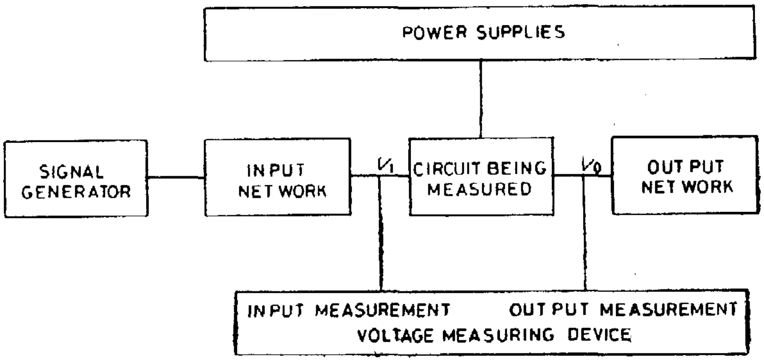


FIG. 5 CIRCUIT FOR MEASUREMENT OF (INPUT) THRESHOLD VOLTAGES AND HYSTERESIS VOLTAGE

d) *Specified Conditions*

1. Temperature (T_{amb} or T_{case});
2. Supply voltage(s);
3. Characteristics of the input signal;
4. r_{amp} voltage linearity, rise time (t_r), fall time (t_f), signal amplitude;
5. Stepped voltage: voltage difference in each step (ΔV), hold time for each step (Δt), signal amplitude;

   t_r, t_f and Δt of the input signal should be much greater than the propagation time t_p of the circuit being measured.
6. Input and output networks (including stray capacitance), and
7. Conditions at other terminals.

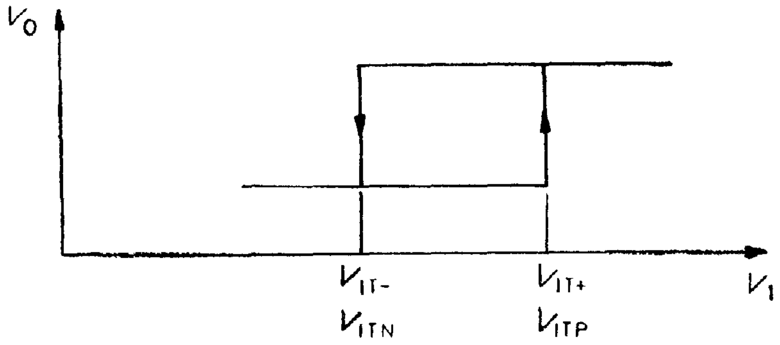


FIG. 6 TRANSITION DIAGRAM

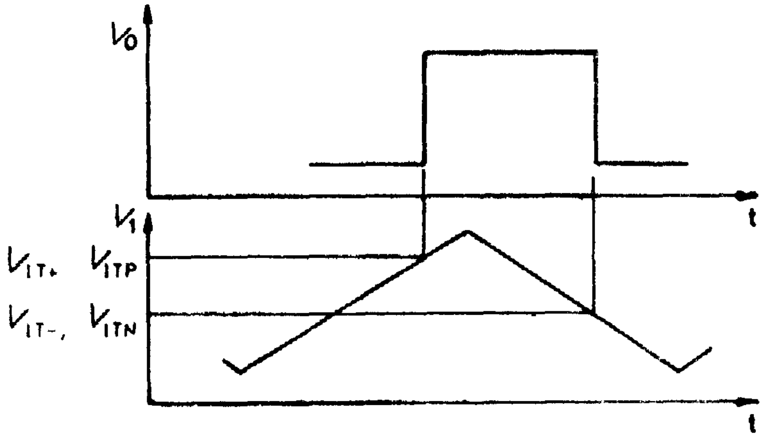
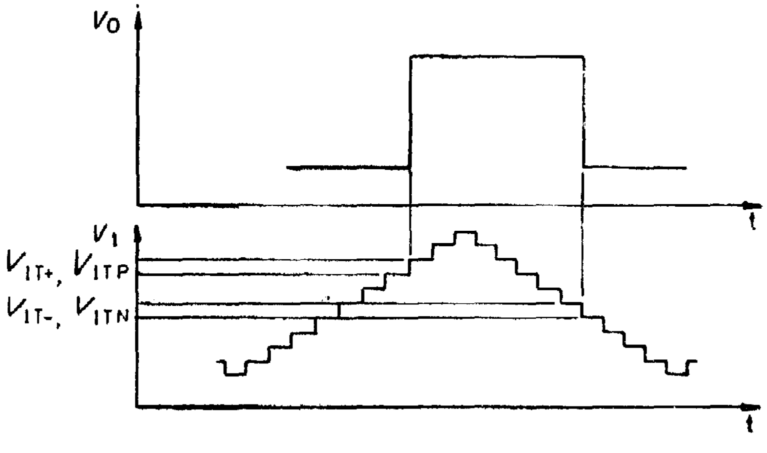


FIG. 7 TRANSITION CHARACTERISTIC LABORATORY MEASUREMENT



NOTE — The precision of the measurement is a function of the amplitude of the steps, which must be taken into account.

FIG. 8 TRANSITION CHARACTERISTIC UNDER AUTOMATIC MEASUREMENT

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